

Curriculum Innovation: Difference and Resemblance

Una Hanley and Harry Torrance
Manchester Metropolitan University

How do teachers respond to a mathematics curriculum innovation? This paper reports some of the findings from a UK Research Council (ESRC)-funded project investigating how teachers in English secondary schools (students aged 12–16 years) responded to innovation. A Gatsby Foundation funded program implemented new materials; the project investigated processes and expectations of implementation. In this paper, we consider the ‘gap’ between innovation and proposed practice from the position of the practitioner, employing the work of Foucault (1995) and Deleuze and Guattari (1998) as a framework for analysis. The paper takes a theoretical position, arguing that teachers construct individual and constantly changing amalgams of practice. These are founded on ‘difference’ and understood in ways, which are shifting, and partial rather than ‘known’ via a sense-making process. Expectations of a strong correspondence between innovation and teacher response have undermined alternative perspectives that regard the interruption and re-routing of innovation as productive of viable outcomes in sites of practice.

Introduction

Curriculum innovation has a chequered history with many accounts over many years detailing the ways in which the interpretation and mediation of new programs takes place in practice (e.g., Ball, 1988; MacDonald & Walker, 1976). The logic of introducing a new curriculum initiative is that it will bring about improvement in practice. While there is some research that demonstrates enhancement (e.g., Hickey, Allison, & Pellegrino, 2001; Swan, 2000), there is a burgeoning literature that emphasises the problematic teachers experience when faced with innovation and the difficulties of bringing about change (e.g., Prestage & Perks 2001; Warfield, Wood, & Lehman, 2005).

In disseminating excerpts from our findings, we have employed theoretical framings which seek to open up ideas and assumptions around the ways in which individuals relate to the social world that they inhabit, in this instance, teachers and their practices (e.g., Brown, Hanley, Darby, & Calder, 2006; Cobb & Bowers, 1999; Walshaw, 1999). In particular, this paper seeks to contest the technical rational models, and the orthodoxies associated with these rationalities that organise and ‘account for’ the world in ways that are increasingly difficult to challenge. In order to do this, initially, we work to make more explicit the ways in which ‘rationality’, strongly associated with self-determination, orientates concepts in specific ways that limit possibility. We then turn to Deleuze and Guattari (1988) to find a means of conceptualising the contested spaces of the classroom. We favour an approach which, broadly post-structuralist, allows us to suggest a world where both the individual and the characteristics and qualities of the context she inhabits are founded in ‘difference’, (diversity, multiplicity)

which flounder on national policies favouring a curriculum which presumes to serve the needs of all pupils while tightly prescribing particular pathways to be followed.

The paper is organised in the following way. In the first section, we offer a brief account of the literature which problematises the relationship between the individual and context, particularly in relation to innovation. We briefly describe the difficulties faced by the practitioner working in complex environments that do not lend themselves easily to imposed technical rationalist models for teaching. Secondly we introduce the research study of curriculum development in mathematics education from which this article derives, and review the promise of Deleuzian ideas for re-thinking curriculum development. Thirdly, we present data from the study and finally we reflect upon the data challenging the expectation of close correspondence between curricular recommendation and practice and to acknowledge the possibilities rather than the difficulties, in variation.

The Troubled Area Between the Individual and Practice

In England, the economies of globalisation and the policies generated in support of them have received their share of critique (e.g., Brown & McNamara, 2005; Brown et al., 2006). However, they become repositories for the fantasies of policy makers producing powerful and sometimes conflicting discourses and regimes of truth (Walkerdine, 1990) around 'solutions', played out in schools in increasingly rapid cycles. Policy demands continue to entail performativity, competency and accountability for teachers and an assessment focussed, skill based curriculum for students (Furedi, 2009).

More recently, in England, innovation has tended to be driven by government in the context of the National Curriculum. In the continuing search to raise attainment levels policies have become increasingly prescriptive in relation to the approaches to teaching and learning which might be adopted. In this scenario, teachers are faced with increasingly rapid cycles of change set in an environment characterised by target setting and accountability (Ball, 2003). Anecdotally, the participating secondary teachers describe how this limits the scope of their activity as they face the necessity for constant adjustment, working to accommodate curriculum change and associated practices – assessment, individualised learning, and pace, to select a few.

A skills based curriculum has the effect of presenting teaching as performative (Ball, 2003). In this new world, knowledge and understanding are shoe horned into 'skills' that can be disseminated rapidly and in predictable order. For example, of the recent curriculum changes, Ball (2003, p. 3) suggests, "... central to its functioning is the translation of complex social processes and events into simple figures or categories of judgement". In the National Numeracy Strategy [NNS] (Department for Education and Employment [DfEE] (1999, 2001) and its associated Framework (referred to in this article as the National Numeracy Framework [NNF]), learning was presented as linear, and the curriculum materials as transferable knowledge, easy for teachers to

internalise and 'apply' to the developmental pathways of students. All this serves to create an illusion of pedagogical clarity.

Rational choice theories (Spillane, Reisser, & Reimer, 2002), complement technical rationalist approaches in that they support the implicit conventions of the latter and create certain assumptions around innovation 'failure'. Within this perspective, a few 'accounts' arise frequently; for example, difficulties with implementation may be owing to the fact rapid cycles of change reduce clarity of intentions and introduce cynicism among teachers (Higham, 2002) and teachers are unwilling or have a limited capacity to respond appropriately to policy requirements (e.g., Ball, 1994; Thompson, 1984). Pedagogy as transferable knowledge generates specific difficulties as in this scenario, as it is assumed that the teacher, as rational subject, is able to 'think things through' and apply her newly acquired curriculum knowledge within her professional space.

These perceptions appear to persist despite more nuanced accounts around reform implementation that acknowledge the complexity of the sense-making processes of individuals. Some of these perspectives are founded in a problematisation of cognitive processes, for example, interpretations of recommendations vary significantly amongst individuals as each teacher accords meanings in their respective ways (Brown & McNamara, 2005; Hill, 2001), and the new recommendations appear variously distinct or familiar, workable or difficult to implement, accordingly. Additionally, "theoretical knowledge is not so much transmitted to teachers as mediated and transformed through practical arguments" (Torrance & Pryor, 2001, p. 626). Spillane, Reiser and Reimer (2002) for example, offer a carefully differentiated account of sense-making which elaborates processes which not only consider the preferences of the individual but also the significance of the layered social environment in which sense-making takes place.

However, 'sense-making' is closely associated with a perception of the subject as autonomous and centred. A small but growing interest has arisen among mathematics educators in contemporary continental philosophy (Lerman, 2006), which has sought to undermine the certainties associated with rationality of the kind that implies a self aware subject able to act in a self-evident world (e.g. Walshaw, 1999). Broadly post-structuralist, both Foucault, but more particularly, Deleuze and Guattari (1988), in their respective work have sought to abandon the search for "timeless essences, authoritative interpretations or for underlying structures that organize surface events" (Schroeder, 2005, p. 269) and look for alternative and potentially more creative ways of thinking about the subject and her relation to the structures she must inhabit. We now turn to the research.

Background to the Research

A Gatsby Foundation-funded curriculum development project in secondary mathematics education, based at Manchester Metropolitan University (Eade & Dickenson, 2007) and involving one of the authors, Hanley, provides the context for the ESRC-funded research project, (2005 – 2006) from which this article

derives. The Gatsby Project planned to introduce 'Maths in Context' [MiC] materials, developed by the University of Wisconsin from the 'Realistic Mathematics Education' [RME] approach of the Freudenthal Institute, Utrecht, into schools in Manchester, and then nationally. The focus of the ESRC research arose out of this opportunity to study a curriculum intervention in action, and the trans-national dissemination of ideas and practices in mathematics education. The research investigated the ways in which teachers interpreted and modified new ideas and materials as they developed and refined viable strategies for practice.

The Gatsby project was situated in a context where, at the time (2005-07) all state maintained schools in England were following the government-mandated National Numeracy Strategy. Under the Gatsby intervention, teachers undertook to work with Maths in Context materials, whilst receiving support from university-based tutors via training days and lesson observations with feedback. The former particularly provided teachers with the space and opportunity to review the new materials with others and to discuss difficulties.

The study was essentially qualitative and action research based (e.g., McNiff & Whitehead, 2002). The researchers worked to investigate the process of curriculum development by interviewing teachers in their sites of practice and on training days. They were encouraged to explore difficulties and to reflect more generally on their teaching practices and MiC. The main findings and more detail on methodology are reported in the ESRC Final Report (Hanley, Darby, & Torrance, 2007). The intention of this paper is to re-examine aspects of the data, comprising a series of interviews conducted with two participants particularly, in the light of the theoretical approaches offered here. Whereas more than half the group of teachers ultimately felt comfortable with MiC, these participants had found implementing aspects of MiC less than straight forward. Their data are employed here to provide empirically based examples of our theoretical concepts. Below are some of the more obvious differences which separated MiC from the NNS Framework and which teachers encountered.

Differences between MiC and the National Numeracy Strategy

For the teachers, RME carried a number of distinctive principles and practices that not only needed to be understood but also were different from those implicit in NNF materials. For example, the approaches embedded mathematics in a series of 'every-day' contexts that have been carefully researched for their suitability (Van den Heuvel-Panhuizen, 2003). Student ideas are privileged and there is a problem-solving ethos around modelling processes, rather than presenting mathematics as a body of knowledge to be mastered. The teacher assumes the role of facilitator, stimulating focussed discussion around feasible solutions with a view to student progress, an idea better understood as a concept rather than a viable practice for some of the participating teachers.

While in England, nationally defined attainment targets offer indicative attainment at successive levels, the developers of RME suggest that

mathematical concepts should be embedded in a long-term teaching trajectory (Gravemeijer, 1994), a proposal difficult to embed in a program orientated around frequent assessment. Concepts learned in context at one stage need to be understood and moved toward symbolisation and abstraction. As there is a strong belief that this happens non-linearly and slowly (Gravemeijer, 1994), current assessment instruments in England were ill suited to reflect student development, and additionally, notions of pace regarded nationally as a feature of a good lesson, were largely inappropriate here. For MiC to be effective, the teacher needed to be committed to the materials and associated practices as a whole and for an extended period. In the circumstances, MiC was experienced as rather risky.

Mathematics Education and 'Resemblance'

Foucault (1995) and Deleuze and Guattari (1988) are amongst the philosophers who emphasise dispersion rather than unity in relation to the individual and the world she inhabits.

They show that the self consists of multiple voices, rules, drives and energies, all of which exist in disharmonious, countervailing relation to one another. (Schroeder, 2005, p. 269)

In such a world, notions of rational, autonomous thought are difficult to sustain. Further, both Foucault and Deleuze and Guattari undermine the notion of coherence and agency in thought and activity, as envisaged in contemporary "structures of belief" (Walshaw, 1999, p.8) by providing an analysis of the 'hidden' at work in language, tracing how power both 'solidifies' and privileges certain categories of activity, at the expense of others.

In the social sciences, contemporary western philosophy has struggled to free itself from what Foucault (1995) refers to as 'transcendence' that is, having a belief that knowledge resides 'outside' contexts of inquiry and that discourses are an expression of earlier synthesised knowledge and 'truths', although how these are interpreted has varied over time. Foucault (1995) suggests that the relationship between individuals and the institution has been characterised by the role of the latter as the custodian of knowledge with which individuals seek an identity characterised by 'resemblance'. This is underpinned by a process of incorporation from the 'outside' to the "essential nucleus of interiority" or sense of self (p. 121). Although the "essential nucleus" of the self is fragile and dispersed, this sense of coming to know that which is perceived to be exterior to ourselves gives us a counterfeit sense of certainty together with an illusion of understanding, which increases over time. In the context of curriculum innovation, curriculum innovators and trainers assume that their efforts will lead to practitioners gaining an interior representation of the proffered recommendations, enabling practices to be assimilated and in turn, utilised.

However, representation 'solidifies', organising knowledge, thoughts, and ideas around certain signifying categories that gradually assume authority,

determining how knowledge and the activity associated with it will come to be known and understood (Foucault, 1995). Categorisation processes fashion similarities, resemblances and generalisations by overlooking 'difference' and the complex 'multiplicity' which characterises both the formation of the subject and the social contexts which the subject inhabits (Deleuze & Guattari, 1988).

Described by Deleuze and Guattari (1988) as a "signifying regime" (p. 114), when reified, the categorisation process closes down alternative points of view. In England, the categories, 'creative', 'pacey', 'interactive', for example, associated with the NNF are intended to bring about modification in teaching practices, and create both goals for practice and measures of apparent success. Reiteration of these and other categories in policy and curriculum documentation, acts to re-affirm their authority. The sought after rise in levels of attainment, for example, tends to increase intolerance of alternatives in terms of the teaching approaches which can be adopted at any one time, causing considerable difficulties for the practitioner in situ. The practitioner is thus caught in innovation as 'resemblance' or representation, reified in attempts to reproduce the characteristics of the innovation in her site of practice.

In our discussions with teachers over the duration of the project, problems experienced in the highly organised spaces which are sites of practice, were sometimes difficult for the teachers to talk about as they are strongly associated with feelings of inadequacy – in relation to planned objectives, incorporation of new approaches, getting through the designated material, to bring about desired discussion, or to manage a class adequately. These were just a few examples. In these circumstances, teachers tend to acknowledge lack of 'fit' as their responsibility. McNamara and Corbin (2001, p. 280), for example, argue that at any one time, teachers' talk is "shot through with different discourses, regimes and registers" which are proffered as a basis for judgements, and that these represent "different rationales and warranting appeals". These features of classroom experience are echoed by Roy (2003) who, working with Deluzian concepts, comments on the difficulties teachers experience in "containing divergence within technomanagerial spaces" (p. 8), that is, subsuming all the variations in their site of practice under a blanket of standardised criteria and recommendations

Changing Theoretical Concepts

It is not the intention here to review the limitations of conventional ways of thinking about the relationship between practitioners and innovation, but to contribute to accounts which problematise the causal thinking which simplifies the relationship between the practitioner and her site of practice. Foregrounding difference, Deleuze and Guattari (1988) offer a conceptual framework outlining alternative insights, which have the potential to help us, reconsider the nature of this dynamic. They suggest that every entity, including ourselves is composed of 'multiplicities' which are in a constant state of movement. Beneath the apparent surface uniformity clustered around categories, there is a flux of disparity and divergence – 'multiplicity', which renders the apparent correspondence around categories, insecure. Both the individual and context she inhabits are an effect of

the flows of life, or intensities, which turn at differing speeds, “the sum total of the intensive affects which it is capable of at a given power or degree of potential” (Deleuze & Guattari 1988, p. 260). Subjectivity is produced by intensities as they shift, connect and diversify, producing varied possibilities.

These processes do not follow a linear pathway, in the sense that the individual can move from one state of self into a goal orientated other sense of self, the process of ‘becoming’ is rather less predictable. In this scenario, teachers and their students are not entities which transcend their environment, but a part of the differential flow which creates it.

Deleuze and Guattari (1988), favoured geological metaphors which portray possible links between intensities as permeability or porosity, emphasising the potential for one entity to mingle with another. However, whereas a categorisation process, forces one entity to become subsumed into another, “smooth space” (p. 353), allows for interrelations or some form of synergy between one intensity and another, providing openings for something more creative. Potential for creative ideas is developed further in their notion of rhizome that illustrates the fluidity of both subjectivity and thought. The significance of the metaphor ‘rhizome’ is that its growth systems are far less predictable than those of ‘arborescent thought’ – a tree or root metaphor strongly associated with contemporary knowledge and thought where roots grow to a predictable pattern which “plots a point and fixes an order” (p. 7). A rhizome denotes no ‘beginnings’ and ‘ends’, and the notion of entities situated in relation to one another is significant here as it privileges the idea of a fluctuating reality where concepts proliferate, coming together perhaps temporarily to create an ‘assemblage’, a temporary fixing of ideas and concepts, which are viable in a particular context for a time. An assemblage is less the product of considered thought or a specific goal and more a viable outcome garnered from a range of possibilities circulating at any one time, enriched by strands of affect, desire, perception and cognition, interdependent entities (Storbeck & Clore, 2007), sometimes interacting inharmoniously. Together, these have an effect upon the experiences that the subject encounters and influence future possibilities.

It needs to be emphasised here that Deleuze and Guattari regarded rhizomatic thought as filled with potential and not a regrettable deviance from a supposed ‘resemblance’, or normalising framework. While fixing things temporarily, an assemblage is also a site of instability. An assemblage became a useful concept in the research reported here, referring to the ways in which certain ideas or features of practice became more established in a practitioner’s repertoire, although perhaps impermanently. In their work, Deleuze and Guattari (1988), sought to capture the ebbing of ideas already assumed and the in-flow of new ones, which are held temporarily together as meaning is made and re-made in ways that are not necessarily predictable, but which respond to the demands of immediate as well as the wider environment.

To take a classroom example, one of the teachers who worked in a school serving an area of social deprivation, worked hard to introduce discussion into his classroom. This was more difficult to introduce into some classes than others

as students responded differently. To ease the process, he opened proceedings in a light hearted and bantering fashion in order to engage interest – his ‘zone’ as he put it. A background of first-hand knowledge of the students in the class, and their varied dispositions, theirs (and his own) strands of affect, desire, perception and cognition, and other ‘awareness’s’ around his sense of the demands of the curriculum, featured in both his approaches and their responses. These assemblages were characterised by a consciousness of how the lesson was evolving rather than a predetermined choreography. In Deleuzian terms, an ‘event’ was fashioned in relation to the potential of the intensities present in teacher, student and curriculum, who are not separate from, but part of the flow of intensities which formed it. Where these and similar events worked in acceptable terms and some discussion took place, such approaches became an addition to the teacher’s repertoire, but overall, classroom based discussion continued to be difficult to bring about.

In sites of change, the teacher, already engaged in a complex process where, as indicated, there are numerous entities at play, must encounter and deal with the additional discursive features and their implications, which characterise the innovation. The intensities immanent to this flow and intermingle making certain possibilities more viable as desirable outcomes than others, at any one time. The notion that pre-determined, pre-designed trajectories would necessarily lead to prescribed goals, is thus interrupted. Using Deleuzian concepts as her preferred theoretical framework, Semetsky (2006) describes how the shape of the lesson can be understood as a process whereby, in discussion, individuals seek a form of internal consistency with their intentions in making sense of their experiences.

Background to the Data Collection

We now turn to our data where sixteen teachers from six schools participated, reflecting the range of socio-economic areas in the city. However, this paper is not a research report, rather we have employed excerpts from the interviews with teachers, which when filtered through our theoretical framework, offer some insight into the complexities which teachers face in their sites of practice.

Teachers’ first encounters with MiC took place against existing ‘signifying regimes’ powerful unifying categories, which featured significantly in teachers’ concerns. These centred around planning and preparation time, lesson dynamics, class management and pace, the balance of discussion, independent working and written work, use of textbooks, student engagement, lack of ICT and other preferred resources, differentiation, and conforming to local policies for homework and assessment.

For a time, these concerns took a backseat, as features of the MIC curriculum were privileged, if rather hesitantly, over existing practices. This pathway of heightened anxiety during the early weeks, associated with producing lessons that felt viable, was followed by a degree of relaxation amongst some of the teachers. Simply to state this commonality is, however, to undermine the essentially individual nature of each encounter with MiC. Though each teacher

mentioned most if not all of the problematic issues identified above (discussion, differentiation, etc), the nature of the smaller and enduring cluster of concerns that characterised an individual's response was particular to them, as was the pace at which this cluster changed over time. From the outset, we observed that experiences were marked by difference.

Based on their work with the first Gatsby cohort (2004-2005), the project leaders understood that the participating teachers in classrooms would modify the materials and approaches. However, a critical stage proved to be the moment during an early training session when they gave explicit permission to modify or omit parts of the materials, in other words, they allowed for some differences in the ways teachers used the materials with their respective students. This was a timely move on the part of the curriculum development team – they were concerned to maintain the essential features of the MiC materials so that any modifications would reflect features of MiC pedagogy, that is, bear a significant resemblance to innovation principles despite a certain amount of customisation, or 'surface' adjustment. As the project was still in its early stages, this was a long-term aim and the adjustments went ahead based on the teachers' own understanding and preferences, marking differentiated and partial adherence to MiC.

For some of the teachers, the process appeared to be comfortable as new forms of practice were apparently created smoothly around existing preferences offering further opportunities. When asked if the materials felt different, one teacher responded:

They do but I don't know whether it's the way I teach it. See, you can give me any material and I'll put my teaching style to it or I might re-jig it in a way that it does feel right ... it feels enjoyable working with the material ... me twisting and changing things, put my bit to it.

There was a strong sense of synergy with MiC in this teacher's descriptions of his teaching. Some of these changes were planned, but others occurred rather more 'on the hoof' as in rhizomatic thought, as the lesson progressed and changes emerged and appeared viable and there are a number of such examples. However, for others, and in contrast, shaping the innovative materials and practices to suit classroom needs was difficult to bring about, as evidenced here in considerable uncertainty:

... I've been sort of, basically do it sort of when I get a chance. I started the book a bit late because we were doing other things and I thought I picked the wrong book, because I chose to do 'Fraction Times' rather than 'Sum of the Parts', and because I thought that 'no, I think my group should be good', because they're quite good, and I thought 'no', and then I was struggling. And I'm, you know ... have I done the right thing? They don't seem to be getting it ... But it's getting much, much better. I really don't like using the bars to make pie charts. I know why they do it but for the kids they physically can't do it. It's too fiddly.

It appeared that MiC materials were quickly metamorphosing in differing ways although degrees of difference remained unclear as teachers oscillated

comfortably and uncomfortably, between new and older practices, resonant of the experience outlined above. Some adjustments appeared to be more secure than others and at this point it is useful to refer back to Deleuze and Guattari's (1988) use of 'assemblage', a term which embodies a loose collection or intermingling of viable possibilities. The emergent practice modified both older and newer understandings of teaching approaches, yet was necessarily responsive to the contextualising social practices of the classroom as well as MiC principles. However these understandings were always subject to the filtering processes of the individual as she worked to smooth out the difficulties associated with intervention, in order to create workable lessons.

Roy (2003) discusses the difficulties teachers experience and points to the "impossibility of dealing with difference from the perspective of unity" (p. 9). Using Deleuzian concepts, he considers the difficulties created by the assumption that innovation presides over sufficiently homogeneous classroom to make 'resemblance' viable overall. The NNE, for example, enforced a curriculum where pace and coverage marked powerful categories for appropriate practice as well as the ever present need to create a classroom environment conducive to learning by privileging orderliness over other features of the lesson. For some teachers, this narrow conceptualisation of the curriculum was an active impediment to thinking differently and they found attempts to juggle the varying demands made of them, variously difficult.

Looking for Viable Assemblages

These points are illustrated in the two sets of extracts presented in this section, orientated around 'discussion', a pivotal issue for all the teachers at various points. These data have been selected as they illustrate more vividly some of the difficulties associated with relinquishing existing preferences and the creation of viable practices. By the end of the year of the project, Christine found some new possibilities for practice, however, despite a belief in MiC and its principles, Carol struggled to incorporate the materials in the ways she understood they needed to be used. These teachers were forthcoming about the struggles they experienced and their attempts to create assemblages with MiC ways of working, are offered in some detail here to illustrate the too-ing and fro-ing between what felt possible and what felt secure.

Christine

An experienced teacher, Christine had come to rely rather heavily on textbooks. While at the beginning of the project she recognised discussion as potentially useful, it became clear during our observations and discussions that this did not regularly feature in her classroom practice. Here she used MiC as support and initially discussion, while desirable on the one hand caused discomfort on the other:

Yes, it's quite nice to actually have discussions with the kids. They're putting their hands up and actually explaining things ... [a little later she says]... when

they have discussions in groups, I sort of feel a bit out of control ... I'm going to have to just live with it because I think the more I do it, the happier I'll be that the discussions are on task.

Christine began to customise approaches, selecting questions from the MiC materials and presenting them to the whole class as a PowerPoint presentation, a technique she preferred, to provide a focus and yet to retain control of some of the classroom interaction. In pinning down discussion as curtailed but required activity, she missed the opportunity to engage with this as an aspect of the 'flow' of lesson intentions

You have to have discussions, yes and one of the things I was less comfortable with was letting the students have a discussion amongst themselves. ... [but] then they feed back to the rest of the class and that's me making sure, still keeping the control.

A little further into the project, Christine realised that her preparations for discussion needed to focus on mathematical concepts rather than arrangements to facilitate control. This realisation marked a shift from simply customising material and recognition that her habits were a critical aspect of the way the lesson moved along:

... my management of that discussion is not there yet. .. It's probably my lack of preparation. I've got to a certain point where I've prepared enough, but I haven't actually sat down and thought about what I'm expecting from the discussion all the time ... then when I get a response back I'm having to think about whether it's actually leading me anywhere.

There is a strong sense of ebbing and flowing in the data in terms of Christine's regard for discussion and the need to be in control, and at times coherence appeared rather tentative. Her assemblages had features, which appeared at odds with one another as she sought both to hold onto and relinquish aspects of practice. By the fifth visit of the year, she was continuing to record both difficulties and successes. She began to acknowledge the perspectives of students, and their concerns for the 'difference' they perceived in the new approaches and she conceded that they also needed time to re-consider their ways of doing things:

... it's actually almost about training us to work together ... they've got to work with me and I need to learn how to work with them.

Yet at the same time and perhaps in search of some certainties, she acknowledged an awareness of MiC pedagogy. She reported:

I'm going to get odd replies but when you are having discussions about not necessarily mathematical topics [e.g., context] then people go off at a tangent and kids go off at more tangents than adults ... they don't see anything wrong with that.

So while, on the one hand, in MiC terms, compromising the pedagogical value of

discussion, Christine was, on the other, also able to 'step back a bit' to give the students more space to say things they felt were relevant.

However, in an assemblage, where conflicting ideas may rub alongside uncomfortably, there is a sense in which the students 'go(ing) off at a tangent' continued to bother her. It later became clear that spending time discussing features of the context with the students, which Christine had perhaps regarded as unnecessary initially, made her more aware of her own propensity for 'jumping in to teach the abstract' and that she was still inclined to do this:

... yeah, I mean being conscious of it is one thing but being able to then change it is quite different.

Christine's ensuing practices were marked by an endeavour to delay this 'jump' and she became more confident. In her final interview, rather forgetting her initial statements of enthusiasm but perhaps marking the varied trajectory of her affiliation to MiC, she says:

... a year ago I would have said, you know, discussions were the one thing I hated ... that wasn't how my classroom worked ... by having to do it, it's made me more comfortable with doing it.

This had been a difficult year for Christine. From her own point of view, the materials had not been easy to use, disrupting her preferred approaches. From the point of view of the RME/MiC project, consistent and successful use of MiC materials had been difficult to observe. However, this is to undermine her search for possibilities. Christine's assemblages for practice gradually appeared to become more viable as RME/MiC practices, as she understood them. Importantly, she had begun to see herself as implicated in the process and flow of the lesson in ways she had not considered, an important step beyond customisation. She had, for example, begun to theorise about how to use discussion rather than simply accepting that discussion should be planned and organised in advance. She recognised her tendency to leap into abstraction before her students were ready and worked to modify this. Changes had taken place, despite the difficulties, although perhaps not in forms that the project leaders might have initially anticipated, that is, corresponding very closely with MiC recommendations as set out in the literature.

Carol

As a newly qualified teacher (NQT), Carol had entered teaching enthusiastically as a novice. After a year's experience, of dealing with 'difference' from the perspective of 'unity' (Roy, 2003), in other words, becoming aware from experience of the disparity between curriculum recommendations aimed at all students and practice which encounters individuals, she had this to say:

... the theory of teaching maths is fantastic, the reality of teaching maths isn't as good because you are stuck with the time constraints and you're stuck with the

fact that the kids have to achieve certain levels in year 9 [aged 13-14yrs] and year 11 [aged 15-16 yrs].

As with Christine, classroom discussion also arose as an important issue for her. Carol's training had led her to believe that 'discussion' was an important element of pedagogy, but working with MiC in the classroom confirmed her views that discussion was tricky to generate. Furthermore it was difficult to reconcile with NNF recommendations for pace:

Ok, the problem was earlier on I thought there was too much discussion going on. I felt like the kids were bored and I was bored and looking back it was because every single question was being answered, written down, then discussed and then discussed some more. So ... I [thought] about differentiating again ... Some of the kids working, doing more questions and some not doing as many but keeping them together and keeping the pace going ... I think going off today I felt much better in the lesson, the lesson was smoother, it was much pacier.

Students had not responded well to the 'amount' of discussion in Carol's classroom, which was apparently required of them. In juggling her past affiliations together with current concerns, the difficulty was rather readily interpreted as an issue of differentiation and pace, significant issues for the NNF and which continued to filter her experiences in particular ways. Here there was a problem as MiC advice suggests that students ought to stay together as a class. However, a decision was made, rather irrespective of pedagogical opportunity: "We talked about the first couple of questions and then moved on". This sense of shifting and turning, between MiC pedagogy and NNF requirements, was very present in much of Carol's data.

As a move to improve things, Carol customised her arrangements and began to time her discussion into measurable intervals of five minutes, but there were other difficulties:

I like them to talk to one another. I don't like them sat there silently working [but] some kids are coming to me saying, 'miss, it's too noisy.

Despite this, Carol maintained her faith in the view that MiC resources were valuable and worked to incorporate the materials in an exact fashion in ways that her more experienced colleagues did not. However, the recursive style of the material seemed to limit possibilities for discussion even further for her, as mid-project, she went 'through' the material rather routinely: "sometimes it does get a bit tedious ... it feels like you're going through it again and again". Some of her more experienced colleagues had been customising material for some time in order to add variety and enjoyment. On occasions, materials had been shared and she had been glad to employ these, but additionally she began tentatively to customise the materials herself. This marked a small shift from her sense of the authority of MiC and NNF and that there were other possibilities, which might and could be, opened up, although this appeared very risky.

And I think it's difficult you know, alright, you sit back at the end of a lesson and you think, right, ok, I spent too long on that, what am I going to do next time? ... and the next time you spend too long on it and you think what am I going to do next time? ... And I think sometimes it's nice to have a completely neutral view, saying 'oh, this is how you do it.

Powerful categories set up alternatives as oppositions. The impact of the NNF positioned MiC in this way for Carol. There was apparently little possibility of permeability or synergy here, as for her, the characteristics of one approach appeared impervious to the characteristics of the other. Thus there was a strong sense in the data that, despite her developing understanding of the materials, her prior affiliation with the NNF and its undoubted authority, posed problems. In relation to the difficulties 'produced' by discussion, obstacles threatened to outweigh benefits. Her desire to be told 'how you do it' pre-supposed an ideal version in place elsewhere perhaps where 'difference' had been tamed and where perhaps students' desires and curriculum manifestations were in closer correspondence.

However, and rather surprisingly, her faith in MiC continued, as she believed that the NNF strategies might bring a form of success in the short term but posed greater problems for students in the longer term. She summarised:

... In an NNF lesson, it's more about kids getting the answers right and less time is spent looking at the method than on the answers and also that runs in line with less time spent with the context... than there is straight into the abstract so I think it is less likely in an NNF lesson that you would discuss method and more likely that you would just sit there and mark answers. Now that's something that I am trying to move away from because I don't think it is worth doing at all...so I'm trying to go round and do MiC in NNF [lessons] ...

Carol understood how the materials 'should' work and therefore the importance of discussion as a way of explicating thought rather than merely providing answers. Her strong attachment to the principles of MiC as discussed on training days, energised her persistence rather more than the experience of 'successful' implementation in her year group. However, she fully intended, "to dip into it as an extra resource" with other teaching groups.

Over the course of the project, while each teacher sought to develop their approaches, it cannot be said that their respective trajectories were either linear or 'aimed' at a pre-determined point. This made the process of adjustment to the innovation feel unpredictable and untidy. Rather than constituting 'improvement' along a recognised 'arborescent' or single trajectory, the too-ings and fro-ings and shifts were strongly resonant of 'rhizome'.

The excerpts here focussed on difficulties for the practitioner, but there were a number of teachers for whom the experience was rather different and who worked more creatively with the materials. For example, the process of recasting relationships with key pedagogic concepts like discussion, led in turn to some sensitivities around how other (non-MiC) lessons were taught amongst other teachers. One response to these feelings had been for teachers to use MiC creatively with non-project classes where a mixture of skills and content was

exported to create new assemblages for practice. Paradoxically, in resisting 'resemblance' to either the NNF or MiC, opportunities to be more creative with materials, unfolded. Christine in particular was one of a number of teachers who found cross-evaluation between the NNF and MiC a helpful process. This created a register and a space whereby they were each better able to judge MiC in relation to the NNF, or earlier practices, and consider possibilities for change which could be regarded as 'improvement'. As one of the participating teachers explained:

I've enjoyed teaching it. I don't think there's anything really that I would say jars with me. I have enjoyed the lessons, and for me, it's made me think about planning lower down the school. Like some of it I sort of think I take for granted that I can teach fraction and decimals and usually spend my planning time on my further mathematics lessons and things like that. It made me think about my teaching lower down the school.

Discussion

The term trajectory is employed by RME to denote a non-linear pathway for learning. This notion resonates with Deleuze and Guattari's (1988) idea of 'lines of flight' which pre-supposes complex and shifting sets of intensities through which the individual creates an assortment of pathways. This is expressed in the concept of 'rhizome'. The term 'assemblage' captured the ways in which entities present in the field of activity coalesced variously, harnessing multiplicity if only briefly, into a practice which may or may not be viable. Christine's data is an example of the way in which aspects of the proposed innovation were made practicable over time. However, after a year of the project the participants remained a very mixed group of teachers who, while developing their own pathways, were not equally wedded to the innovation.

It is tempting to dismiss both Christine's and Carol's attempts to work with innovation as ineffectual. However, techno-rationalist views of teaching judge teachers' responses to innovation in the degree to which 'resemblance' can be determined. As Roy (2003) suggests, the

... conventional approach to curriculum is to get teachers to move toward a more certain ground, toward more rigid planes ... through higher requirements, testing, certification and so on. (p. 132)

Policy and the curriculum innovation set up in relation to it are heavily concerned with regulating spaces which sideline "irregular becomings, the actual starts and stops, the faltering, the errors and accidents, desires and other complexities that constitute complex learning" (Roy, 2003, p. 132). This is a timely perspective. Teacher agency draws from an uncertain subjectivity, which following Deleuze and Guattari (1988), arises as an 'effect' of possibilities present at any one time and is in a continuing process of becoming. Their metaphors, 'multiplicity', 'rhizome' 'intensities' and 'flows', for example, shift the stability implied by 'arborescent' knowledge into the dynamic process of knowing and the contingencies that arise around this process. In the light of this, normalising

frameworks are interrupted, challenged, and re-routed as ideas are constantly formed and re-formed in sites of practice.

Concluding Thoughts

In the considerable range of research which records the difficulties experienced by teachers in instituting innovation, there is a growing acknowledgement amongst mathematics educators that curriculum change is complex and fluid rather than mimetic and 'fixed'. In referring to Deleuze and Guattari (1988) we intended to join the conversations around teacher participation in innovation from a position that foregrounds the differences in teachers, pupils, curriculum and sites of practice which cannot be circumscribed and moulded in ways which can be readily anticipated. The concepts developed by Deleuze and Guattari (1988) around difference, multiplicity and the energies created around these, allow for a way of seeing productive 'forces' alongside prescriptions for innovation and in sites of practice, where each influences the other. Here, practices do not lend themselves easily to rational choice theories, indeed 'rationality', can already be seen to be a troubled term.

For Deleuze and Guattari (1988), the flows and shifts that characterise social contexts, are the sites of potential. This needs to be recognised. While the pathways of new practices are not necessarily predictable in ways anticipated by curriculum trainers, and appear temporary rather than stable, there is a potential for something more creative.

Innovation of any kind often arises as an outcome of 'conditions of possibility' rather than founding principles (Mouffe, 1996). This suggests that change has its own momentum that relates to prevailing cultural and political conditions rather than the invention of the 'ideal' curriculum to which all teachers must adjust (Brown et al., 2006). Yet each move toward innovation seeks improvement on earlier versions and a strong correlation between advice and practice. Referring to a 'grail', Watson and De Geest (2005) propose that,

... we may be looking in the wrong place, and for the wrong thing: methods, organisations, structures and tasks may not be as important as principles and their supported manifestations (p. 231).

However RME/MiC comes to be judged in the future, the founding principles and supported manifestations of the program were tolerant of individual ways of working. The 'wrong thing' to look for would be a close identification with particular sets of methods and structures. Acknowledgement of individual teacher's situatedness in particular contexts and the processes in which they engage are key to a fruitful dynamic between pedagogical theory and practice. Roy (2003) suggests, that the problem teachers face in finding their feet in a fluid environment

... could be seen as a semiotic problem: that of getting away from signifying regimes that project the signs of learning as bounded, convergent and a function of representation. (p. 116)

He advocates experimenting with “the multiple ways of making connections that continually undergo change and reveal unexpected and irregular learning opportunities” (p. 116). Our findings suggest that the teacher’s association with curriculum innovation might be better understood as a set of relationships where each is permeable to the other, and characterised by fluidity, difference and resonance, accounted for in varying ways, as teachers work to weave their developing sense of practice in situ. Accordingly, their fidelity to central ideas might also be better comprehended in the features of their assemblages for practice which they create, and with which they co-construct the curriculum.

Acknowledgements

We are indebted to the generous participation of the secondary school teachers participating in the study. We would also like to thank Frank Eade and Paul Dickinson, leaders of the project financed by the Gatsby Foundation (2004 – 07) for their support and Sue Darby, research assistant on the ESRC project. ESRC reference no: RES-000-22-1082

References

- Ball, D. (1988). Unlearning to teach mathematics. *For the Learning of Mathematics*, 8, 40-48.
- Ball S. (1994). *Education reform: A critical and post-structural approach*. Buckingham: Open University Press.
- Ball, S. (2003). The teacher’s sole and the terrors of performativity. *Journal of Education Policy*, 18(2), 215-228.
- Brown, T., Hanley, U., Darby, S., & Calder, N. (2006). Teachers’ conceptions of learning philosophies: Some problems with consensus. *Journal of Mathematics Teacher Education*, 10(3), 183-200.
- Brown, T., & McNamara, O. (2005). *New teacher identity and regulative government*. New York: Springer.
- Cobb, P., & Bowers, J. (1999). Cognitive and situated learning perspectives in theory and practice. *Educational Researcher*, 28(2), 4-15.
- Deleuze, G., & Guattari, F. (1988). *A thousand plateaus*. Minnesota: University of Minnesota Press.
- Department for Education and Employment [DfEE]. (1999). *The National Numeracy Strategy: Framework for teaching mathematics*. Cambridge: CUP.
- Department for Education and Employment [DfEE]. (2001). *Key Stage 3 National Strategy: Framework for teaching mathematics*. London: DfEE.
- Eade, F., & Dickinson, P. (2007). *Exploring realistic mathematics education: The innovators’ account*. Paper presented at the British Educational Research Association (BERA) Conference, 5-9 September, London.
- Foucault, M. (1995). *The archaeology of knowledge*. London: Routledge.
- Gravemeijer, K. (1994). *Developing realistic mathematics education*. Utrecht: CD-Press Freudenthal Institute.
- Hanley, U., Darby, S., & Torrance, H. (2007). *Final report for the project – Investigating and developing effective strategies for mathematics teaching at Key Stage 3 in the English National Curriculum*. Manchester University.
- Van den Heuvel-Panhuizen, M. (2003). The didactical use of models in realistic mathematics education: An example from a longitudinal trajectory on percentage. *Educational Studies in Mathematics*, 54, 9-35.

- Hickey, D., Allison, A., & Pellegrino, J. (2001). The motivation and academic consequences of elementary mathematics environments: Do constructivist innovations and reforms make a difference? *American Educational Research Journal*, 38(3), 611-652.
- Higham, J. (2002). *Change in the 14-19 school curriculum in England, lessons from successive reforms*. London: ESRC.
- Hill, H. (2001). Policy is not enough: Language and the interpretation of State Standards. *American Educational Research Journal*, 38(2), 289-318.
- Lerman, S. (2006). Socio-cultural research in PME. In A. Gutierrez & P. Boero (Eds.), *Handbook of research on the psychology of mathematics education: Past, present and future* (pp. 347-366). Rotterdam: Sense Publishers.
- MacDonald, B., & Walker R. (1976). *Changing the curriculum*. London: Open Books.
- McNamara, O., & Corbin, B. (2001). Warranting practices: Teachers embedding the National Numeracy Strategy. *British Journal of Educational Studies*, 49(3), 260-284.
- McNiff, J., & Whitehead, J. (2002). *Action research: Principles and practice*. London: Routledge.
- Mouffe, C. (Ed.) (1996). *Deconstruction and pragmatism*. London: Routledge.
- Prestage, S., & Perks, P., (2001). Models and super-Models: Ways of thinking about professional knowledge. *Research in Mathematics Education*, 3, 101-114.
- Roy, G. (2003). *Teachers in nomadic spaces*. New York: Peter Lang.
- Schroeder, W. (2005). *Continental philosophy: A critical approach*. Oxford: Blackwell.
- Semetsky, I., (2006) *Deleuze, education and becoming*. Rotterdam: Sense Publishers.
- Spillane, J., Reisser, B., & Reimer, T. (2002). Policy implementation and cognition: Reframing and refocusing implementation research. *Review of Educational Research*, 72(3) 387- 431.
- Storbeck, J., & Clore, G. (2007). On the interdependence of cognition and emotion. *Cognition and Emotion*, 21(6) 1212-1237.
- Swan, M. (2000). GSCE mathematics in further education: Challenging beliefs and practices. *The Curriculum Journal*, 11(2), 199-223.
- Thompson, A. (1984). The relationship of teachers' conceptions of mathematics and mathematics teaching to instructional practice. *Educational Studies in Mathematics*, 15, 105-127.
- Torrance, H., & Pryor, J. (2001). Developing formative assessment in the classroom: using action research to explore and modify theory. *British Educational Research Journal*, 27(5), 615-631.
- Walshaw, M. (1999). An unlikely alliance: Mathematics education, poststructuralism and potential affirmation. *Mathematics Teacher Education and Development*, 1, 94-105.
- Walkerdine, V. (1990). *The Mastery of reason, cognitive development and the production of rationality*. London: Routledge.
- Warfield, J., Wood, T. & Lehman, J., (2005). Autonomy, beliefs and the learning of teachers. *Teaching and Teacher Education*, 21(4), 439-456.
- Watson, A., & De Geest, E. (2005). Principled teaching for deep progress: Improving mathematical learning beyond methods and materials. *Educational Studies in Mathematics*, (58), 209-234.

Authors

Una Hanley, Institute of Education, Manchester Metropolitan University, 799 Wilmslow Rd., Didsbury, Manchester, M20 2RR, UK. Email: u.hanley@mmu.ac.uk
 Harry Torrance, Institute of Education, Manchester Metropolitan University, 799 Wilmslow Rd., Didsbury, Manchester, M20 2RR, UK. Email: h.torrance@mmu.ac.uk